NATIONAL BUREAU OF STANDARDS REPORT

9453

Development, Testing, and Evaluation of Visual Landing Aids
Consolidated Progress Report for the Period July 1 to September 30, 1966

By
Photometry and Colorimetry Section
Metrology Division

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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NBS REPORT
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Development, Testing and Evaluation of Visual Landing Aids

Consolidated Progress Report to

Ship Installations Division
and
Meteorological Division
Naval Air Systems Command
Department of the Navy

and to

Federal Aviation Agency

For the Period
July 1 to September 30, 1966

By
Photometry Section
Metrology Division
Institute for Basic Standards

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of Visual Landing Aids
July 1 to September 30, 1966

I. REPORTS ISSUED

Report No.	Title
9443	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for Period April 1 to June 30, 1966.

II. VISIBILITY METERS AND THEIR APPLICATION

Slant Visibility Meter.

The field testing of the slant visibility meter has been completed except for issuing the report. A draft of the report has been prepared and presented for review. Work on this report will be resumed after the reviewers' comments are received.

Fog Detectors for the Coast Guard.

Three fog detectors were calibrated by the Coast Guard at Arcata during the previous quarter and then moved to the San Francisco Bay area for visual comparisons. These fog detectors were manufactured by Hoffman Electronics Corporation, Thomas A. Edison Company, and Impuls-Physik GmbH. Plans to return these fog detectors to Arcata for operation through the fog season were cancelled.

The batteries for energizing the detectors, which were left at Arcata, have been picked up. The house trailer, used to house the recording equipment, was left for use on the laser project during this fog season. This completes work on this task.

Transmissometers.

During the installation of the three transmissometers on the 250-foot baseline, some problems were encountered which may be of interest to others. With several instruments installed, crosstalk between signals was a problem. This crosstalk effect was increased by the signal lines running in the same cable for 2000 to 4000 feet. Apparently, the common ground of the indicators was the link in transferring the signal between instruments. Careful adjustment of volume and bias of the indicators did not completely eliminate the crosstalk effect, especially at slow pulse rates. The crosstalk interference was eliminated by isolating the input signals from the grounds at the indicators by inserting an isolating transformer between C213 and S206 and removing the ground connection from the background switch S205 and the input signal line. The primary of the isolating transformer was connected between the low side of C213 and the junction of the J202-A and the low side of background switch S205. The secondary was connected between ground and the junction of S206, R232, J204 and S203. The connection from C213 to this junction was opened. This permitted all background operations to function normally.

The counters in the photopack for recording the signal from the three 250-foot baseline transmissometers for the laser project required a negative pulse input. The transmissometer indicators were modified according to the Weather Bureau Modification No. 13 to furnish negative pulses at the OUTPUT jacks of the indicators for both the normal and calibration signals, but the signals to the counters were taken from the input signal lines which required only the proper polarity at the input to the counters. When the signals were originally connected, one of the counters read about 10 percent too high for the input signal. Measurement of the signal strength found these pulses to range between 18 and 30 volts while the counters were intended to accommodate signals of 12 to 16 volts. Apparently the higher voltages were causing the error in the counter. By using a 4000-ohm potentiometer in series with the input to the counter, the signal voltages were adjusted to obtain satisfactory operation of all the counters. The common ground effect at the counters which may have caused crosstalk was eliminated by installing 0.01 microfarad capacitors between the counters and the positive side of the signal lines.

Shipboard Visibility Meter.

New electronics are being adapted to the previously constructed flash lamp and photocell assemblies. Both mechanical and electrical modifications were made in the lamp power supply. An attempt to delay the flash for the time required to discharge the peak detectors by adjusting the trip point of micro-switches run by the cams on the shutter motor shaft, quickly indicated this was impractical if not impossible. Therefore, a silicon controlled rectifier was installed in place of the switch that discharges the charged capacitor through the primary of the flash trigger coil. This allows the flash to be triggered by an electrical pulse. One cam-driven switch is used to provide a trigger when the shutter is in position for each flash, and another is used to activate the commutating switch that connects the photocell signal to the signal channel when the shutter is in the proper position. Two monostable multivibrators have been constructed. One provides the pulse to drive the peak detector discharging relays and the other provides the flash trigger pulse after the discharging pulse. Both are triggered by the switch that is activated for each flash.

The small isolation transformer originally used with the lamp power supply apparently limited the current output to the energy-storage capacitor. When a larger transformer was used, the voltage on the capacitor when the lamp fired was about 2 kV compared with about 1.5 kV with the smaller transformer. With this voltage on the capacitor, the power dissipation in the lamp at the present flashing rate caused the lamp to heat up to the point where the arc would not go out. An adjustable transformer will be used to adjust the output voltage of the power supply. Silicon rectifiers will replace the mercury vapor rectifiers in the new power supply to be constructed.

The complete system was interconnected and aimed through an open window to the northeast. The weather was usually quite clear during the first few weeks after the system was set up. The bandwidth of the preamplifier following the photomultiplier tube was limited to prevent the peak detectors from charging up to the peak values of the large, rather fast risetime noise peaks which are present when the background light level is high. This noise in signal caused by the random emission from the photocathode was observed to contain peaks several times larger than the signal pulse peak. The effect of the noise was reduced to an acceptable level by limiting the risetime of the preamplifier to about the same value as the signal pulse risetime, 30 μs.

The reference pulse amplitude was found to increase when the background light level on the phototube was blocked off. Investigation showed that the tube was saturating at the high light levels. More than one tube was tried and saturation was still observed with the photomultiplier connected as a photo diode indicating the photocathode itself was contributing to the saturation. The dynode voltages necessary to give the desired overall tube gain were extremely low with the ten stages of the tube. So far the best results have been obtained by placing a 10% transmission neutral density filter over the photocathode and using only four dynode stages, the remaining being connected to the anode. The reference amplitude now changes a few percent when the background light from very bright sky is blocked off. Previously, changes of 40% to 50% were observed.

Fog Variability Studies.

There was no work directly on the fog variability studies on the test site at the Arcata Airport except for routine maintenance of the transmissometers. However during the next quarter, visual observations for comparison with the data from the three 250-foot baseline transmissometers installed on 14-foot high stands for the laser project will be made and correlated with the laser test data. A black target and threshold lamp to be mounted on a pickup truck is planned for use in making the visual observations. The target and the observer will be at the same elevation as the transmissometers on the 14-foot stands.

Sperry Rand Laser Visibility Meter Field Studies.

The project to test the laser visibility meter at the Arcata Airport was approved on August 19. This project is to test a pulsed ruby laser in actual fog conditions to determine its capabilities as a backscatter type atmospheric extinction meter or transmissometer. The laser is furnished and operated by Sperry Rand Research Center as the non-government contractor, and the project is sponsored by the Federal Aviation Agency. The National Bureau of Standards arranged a suitable test range at the Arcata Airport, provided transmittance data for correlation with the laser test results, installed the tower and shelter for the laser, provided power to the site, and provided equipment and working space at the site. The testing is expected to be completed during the current fog season. Since the project was not approved until far into the fog season, the time available for installations and testing is limited.

Much of the planning was completed and some of the equipment had been delivered before project approval. The test site selected is on the northeast side of the airport between runways 31 and 19 as shown in figure 1. This provides a near-level range of 2900 feet on the airport and a horizontal range of two miles without obstruction. The transmittance data for correlation are obtained from three 250-foot-baseline transmissometers spaced along the range and are identified at T-L1, T-L2, and T-L3 as indicated in figure 1. The field units of these transmissometers are mounted on 14-foot stands to have these units at approximately the same elevation as the laser. The indicators and recorders for these transmissometers are located in the NBS laboratory. The signal from T-L1 is brought to an indicator and recorder in the working facility at the laser site for information needed during the tests. The tower and shelter for the laser were furnished by Sperry Rand. A 30-foot house trailer, which belongs to the Coast Guard and was available because it had been used earlier on the fog detector project, was moved to the laser site and used to house the auxiliary equipment and provide working space.

Despite some delays in receiving equipment, the laser installation was completed and operating on September 13. The transmissometer installations were completed on September 14. A photopack with counters for the three transmissometer signals and a camera for photographing the counts at one minute intervals was received and installed on September 23.

III. AIRFIELD LIGHTING AND MARKING

Airfield Lighting Maintenance Manual.

The draft of the maintenance section, Part II of the manual on "Maintenance of Airfield Lighting Systems" was reviewed but considerable revision is planned. The urgency of installations and testing prevented appreciable work on this task. Major work on this task is not expected to resume before January.

Improved Cable Fault-Locating Set.

Testing and modification of the Amplifier-Indicator unit, and building and testing of a prototype model of the Signal Generator continued. The changes incorporated into the Amplifier-Indicator unit consisted primarily of increasing the power available to the headphones and simplifying the amplifier circuitry. The present circuit has passed all tests made so far, with performance at extreme temperatures the only major test yet to be made, so no further circuit changes are contemplated. The prototype model of the Signal Generator is also working well, but testing has not been completed. At this time it appears that any circuit changes made on the generator will be minor. Construction of the final instruments is expected to begin early in November, and the project is expected to be completed by the end of this calendar year.

Improved Heliport Perimeter Light.

An improved heliport perimeter light was designed and constructed using a type M-1 light housing and omnidirectional lens and a Q6.6A/T3/4CL 100-watt quartz-iodine lamp as a light source. A lamp fixture was designed to position the filament to produce a symmetric beam with an approximate elevation of 5°. Photometric tests are awaiting the completion of the electrical work on the new photometric range.

Open-Grid Approach Light.

A study was made to determine the minimum dimensions of an open-grid approach light which would have a 30° horizontal and 10° vertical beam spread with a low-angle cutoff at an elevation of 2°.

Two light sources were considered: one PAR-64 lamp and 3 PAR-36 lamps. The approximate minimum dimensions are as follows:

Light Source	Length	Width	Depth
1 PAR-64	11½ ft.	6½ ft.	1 ft.
3 PAR-36	5½ ft.	4 ft.	8 in.

It was decided to construct a laboratory model of the smaller (PAR-36) type for the purpose of making photometric measurements. The design of such a unit is in progress.

Malfunctioning Runway-Identification Light.

A malfunctioning runway-identification light was tested. The relay which shorts the lamps during the time the motor is accelerating would chatter continuously. The light was connected into a simulated runway-lighting circuit supplied by a 4-kilowatt (type C-1) regulator and operated at each of the five intensity steps.

The malfunction was apparently due to the following:

a. The motor and the turntable were misaligned causing a drag on the motor. This was corrected by realigning the motor.

b. There is a significant difference between the characteristics of the motor-supply transformers used in the present unit and those used previously, and at operating speed the current through the relay was insufficient to hold the relay in the energized position. This was corrected by changing the value of resistor R_1 from 300 to 500 ohms.

Airfield Lighting Cable Connectors Field Tests.

Samples of several types of airfield lighting cable connectors are being tested for performance under long term direct burial conditions. These tests were discussed in NBS Report No. 8106 "Field Tests of Airfield Lighting Cable Connections." The insulation resistances of these connectors on this continuing field test were measured while the ground was dry. There were no appreciable changes in the resistances from those of previous measurements. The sections of the cables leading into the instrument shelter which are exposed to the atmosphere now show small cracks and checks in the outer jacket. The insulation of 5000-volt direct-burial airfield lighting cable lasts much longer when buried in the ground than when exposed to light and atmospheric conditions.

Temperature Rise of L-850 Light With 500-Watt Lamp.

A semiflush runway light manufactured by Multi-Electric Manufacturing, Inc., and a base manufactured by Vega Industries were received for test to determine the temperature rise when a 500-watt lamp is used. The light was an FAA specification L-845 type and the base was an FAA L-850 type. The base was set in a concrete pad in preparation for the test. The top surface of the pad is 30 inches by 30 inches and the thickness of the concrete at the top and encasing the base is a minimum of six inches. After this concrete has had some time to cure, the temperature rise test will be made. This task should be completed early next period.

Three Experimental Condenser-Discharge Lights From NAFEC.

Three experimental flush-mount condenser-discharge light assemblies and two power supplies were received from the National Aviation Facilities Experimental Center in Atlantic City, New Jersey for tests. A memorandum report will be issued.

IV. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

Several Technical conferences relating to problems of visual range and airfield lighting have been attended. Several proposals and draft reports have been reviewed. Particular attention has been given to regulator specifications, proposals for improved semi-flush lights and fog simulators, and a review of draft reports relating to the determination of RVR.

V. MISCELLANEOUS

NBS Gaithersburg Facility.

The construction and installation of the equipment in the lamp and lighting-system test rooms has been completed. These rooms contain a 6-kVA constant-voltage regulator, a type C-1 (4-kW.) constant-current regulator, a cycling console, a simulated airfield lighting system, and seasoning and life test racks.

Goniometer for 300-foot Photometric Range.

After moving the photometric range from Washington to the new Gaithersburg facilities, the instrumentation was redesigned and rebuilt to make it more flexible and easy to use. The old goniometer was completely disassembled and rebuilt using a new variable speed drive system on the horizontal and vertical drives. The vertical and horizontal drives are coupled to a X-Y recorder by a potentiometer mounted on the goniometer and driven by a ten-speed gearbox. It is possible to select a specific number of degrees per division by setting the correct ratio on the gearbox driving the potentiometer. Fine adjustments are made by adjusting the voltage across the potentiometer.

Work on the 300-foot photometric range is proceeding.

RVR At Arcata.

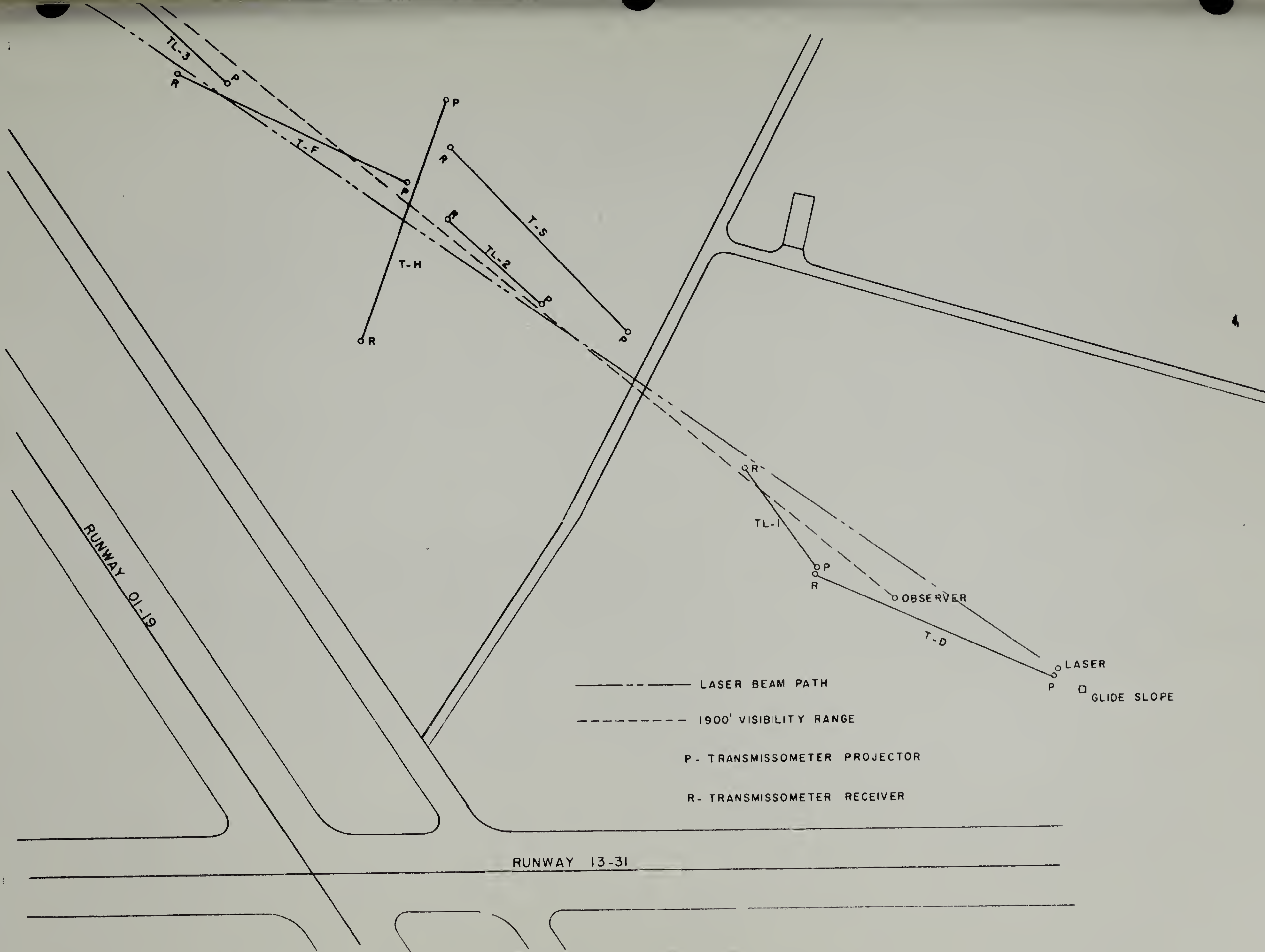
The runway visual range (RVR) equipment at the Arcata Airport has been commissioned. The operating procedures for the RVR have received much discussion especially for use at airports with limited traffic. Reporting procedures require the RVR indication for runway lights at brightness step 5 whenever visibility is one mile or less. If the lights are kept at this intensity for the long periods of low visibility which occur at Arcata, the lamps will burn out rapidly and lamp and maintenance costs can be excessive. The Flight Service Station at Arcata was requesting an arrangement that would provide an RVR indication corresponding to a light intensity setting of step 5 for all light settings except when on steps 3 and 4. This would provide the RVR read-out for reporting without having to operate the lights on high intensity except when actually needed for aircraft operations.

Compilation of Intensity Distribution Data.

Work was begun on a compilation of intensity distribution data of the lights presently used in airfield and carrier lighting. NBS Report 9350 has been drafted containing 114 figures, of which nineteen are reproductions of photographs and 95 are intensity distributions of the lights used in airfield lighting. NBS Report 9350 Supplementary will be issued containing photographs and intensity distribution data of carrier lights.

Two papers "Photometry of Colored Light", by A. C. Wall and "Review of Elementary Theory of the Photometry of Projectors", by C. A. Douglas, were presented at the National Technical Conference of the Illuminating Engineering Society. Discussions of several papers presented at the conference were prepared.

The fourth meeting of the Visual Aids Panel of the International Civil Aviation Organization was held in Montreal, P. Q. August 30 to September 16. It was attended by C. A. Douglas who served as chairman of the meeting.



Installation layout for the laser tests
at Arcata, California

NBS Report 9453

Figure 1